*Final*

# Yukon to Kuskokwim River Engineering Study

Prepared for

**Western Federal Lands Highway Division**

April 2011

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## Tables



## Appendix

# Abbreviations

| | |
|---|---|
| AACE | American Association of Cost Engineers |
| AASHTO | American Association of State and Highway Transportation Officials |
| ACE | Air Circulating Embankment |
| ANILCA | Alaska National Interest Lands Conservation Act |
| ANSCA | Alaska Native Claims Settlement Act |
| AVEC | Alaska Village Electric Cooperative |
| BLM | Bureau of Land Management |
| DOT&PF | Alaska Department of Transportation and Public Facilities |
| EIS | Environmental Impact Statement |
| ESA | Endangered Species Act |
| GDVLVLR | Geometric Design of Very Low-Volume Locals Roads |
| GIS | geographical information system |
| mph | miles per hour |
| NEPA | National Environmental Protection Act |
| NRCS | Natural Resources Conservation Service |
| PCM | Preconstruction Manual |
| ROM | rough-order-of-magnitude |
| ROW | right-of-way |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| WFLHD | Western Federal Lands Highway Division |
| $yd^3$ | cubic yard |
| YDNWR | Yukon Delta National Wildlife Refuge |

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**Section 1**

# Introduction

## 1.1 Introduction

The purpose of the Yukon to Kuskokwim River Engineering Study is to evaluate the feasibility of a road Corridor Between the Yukon and Kuskokwim Rivers, with a starting point at the community of Kalskag on the north bank of the Kuskokwim River and an ending point on the south bank of Paimiut Slough, a modest braid of the Yukon River. This area is the location of a traditional trading and transportation route established because of the proximity of the two major river systems in the region—the Yukon and Kuskokwim, approximately 25 miles apart. The last improvements to an existing boat-tram system in the area were made by the Bureau of Land Management (BLM) in the 1950s.

A Feasibility Study on the proposed route, the "Yukon – Kuskokwim Crossing Route and Feasibility Report" (1981 Study), was last conducted by the State of Alaska in 1981. Thus, a new engineering study will update the 1981 Study and provide a more focused effort on examining the engineering and environmental compliance requirements for the project.

This engineering study will include the following key elements:

- Development of conceptual engineering alignments with costs;
- A preliminary assessment of the environmental conditions, potential impacts, and work required for compliance for the alignments; and
- A reconnaissance-level assessment of major river/stream crossings, geologic conditions, conceptual land ownership, design criteria based on forecasted use, and a conceptual alignment with quantity-based estimates for cost.

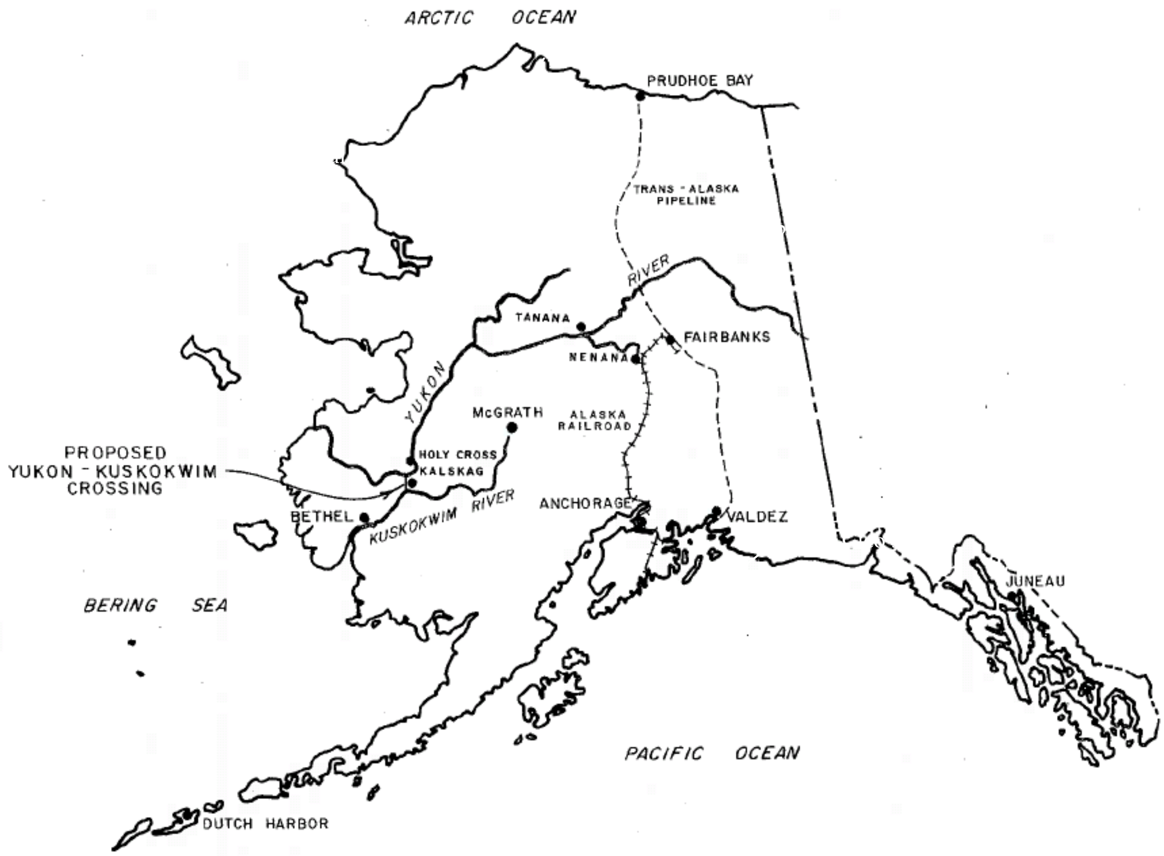
There is no road system to the communities along the Yukon and Kuskokwim Rivers, and barge access is limited by river depths, crossing river bars, and impassable river and sea ice for over half of the year, meaning communities on the Kuskokwim River have limited means for obtaining fuel and bulk materials. The 1981 Study presented the case that "[t]he present high cost of transportation increases the cost of supplies delivered to the villages, and the limited backhaul of fish is not sufficient to reduce waterborne freight rates. Increased tonnage in either direction, of items other than the supplies now being delivered, would assist in lowering prices."

The proposed road corridor would allow supplies to be transported by barge from the road and rail system at Nenana to the Yukon River, then taken over land to the Kuskokwim River and then taken in smaller barges to these communities. There is also the potential benefit of a reverse haul from the Kuskokwim communities to the Yukon River communities and road system that connects to the more populous areas of Alaska.

While summarized in this document, these conditions are further defined in the 1981 Study that analyzes the economic and other benefits of the proposed project.

## 1.2 Project Area Description

The project is located in Southwest Alaska near Kalskag and Lower Kalskag, about 90 miles northeast of Bethel on the Kuskokwim River. The Paimiut Slough is likely an old oxbow on the Yukon River approximately 20 miles southwest of Holy Cross.




PROJECT LOCATION MAP

From Kalskag, the traditional route leaves the Kuskokwim River floodplain in the first mile or two before skirting the western flanks of the Portage Mountains at low elevation for the next 22-24 miles. The terrain is rolling, away from major waterways, and likely consists of relatively favorable soil conditions.

The most difficult section of the route is the remaining 6- to 8-mile section that crosses the old terraces of the Yukon River, with numerous sloughs and ponds present. The soils are likely silty, highly organic, and poorly suited for road foundations. Road construction for this segment will require water crossings as well as large amounts of imported fill.

A significant consideration will be the relationship between the proposed road corridor and the eastern boundary of the Yukon Delta National Wildlife Refuge. Although the traditional corridor falls almost completely within the refuge, the proposed corridor has been tentatively located further east such that southern half is outside the refuge while the northern portion falls inside the eastern refuge boundary. This issue is further discussed in the Land Status section of this document. A Northern Option has been identified which locates the Paimiut Slough dock, but not all of the roadway, to the east of the refuge.

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SECTION 2

# Roadway Corridor Definition

## 2.1 Corridor Alternatives

The 1981 Study describes previous attempts to develop this connection between the Yukon and Kuskokwim Rivers. Attempts range from ancient summer and winter trails, to a 1920-envisioned canal connection, to a pair of 1930 vintage trams, to further studies in the 1970s for developing a canal. The 1981 Study proposed a concept for "a heavy-duty, gravel haul road between the two rivers, with a transfer dock at each end". Subsequent reconnaissance led to the conclusion that the optimum location should be, (a) along the escarpment above the flood plain, (b) with a southern terminus in the vicinity of Kalskag on the Kuskokwim River and, (c) a northern terminus at Paimiut Slough, approximately six miles from its confluence with the Yukon River (1981 Study). Corridor selection focused on the upland flanks of the Portage Mountains (elevations range from about 100 feet to about 1,300 feet) rather than the poorly-drained, ice-rich lowlands immediately to the west. Three corridors were identified in the 1981 study (Figure 2-1 a/b) ranging in length from about 27 to 35 miles, with modest grades of 3 to 7 percent to accommodate heavy haul traffic. The northern termini of each alternative are located on Paimiut Slough, while the southern termini are located on the Kuskokwim River between Kalskag and Chuathbaluk, a straight-line distance of about 39 miles. Corridors A and B cross through low passes in the Portage Mountains and are aligned generally along narrow valley bottoms. Both have grades of 5 to 7 percent. The primary corridor is aligned near the base of the west flank of the Portage Mountains and has no significant grade. Its southern terminus lies between Upper and Lower Kalskag, 24 and 39 miles downstream, respectively, of the terminus of Corridors A and B. The location of the southern terminus of the Primary Corridor is advantageous in that it would make use of existing infrastructure in the Kalskag area, it is river-hours closer to the regional center of Bethel, and it is presumably more navigable than waters further upstream.

Corridor B is the only corridor that is located completely outside of the Yukon Delta National Wildlife Refuge. The northern end of Corridor A falls within the refuge boundary, although it could possibly be relocated outside the refuge to the east. The northern half of the Primary Corridor, as defined in the 1981 Study, falls within the eastern boundary of the refuge. This corridor has been refined through use of aerial photographs and helicopter reconnaissance using GPS technology to map the terrain best suited for a heavy haul road, though it did not significantly reduce the corridor length within the refuge. An additional Northern Option was identified that moved the northern terminus of the Primary Corridor further upstream on Paimiut Slough, outside of the refuge. A benefit may be realized in having the northern terminus's dock and staging area moved outside the refuge. However, the Northern Option alignment remains on the thermokarst and is not conducive to heavy haul road construction and maintenance.

**Primary Corridor—**The following alignment description is taken from the 1981 Study. Refinements to the Primary Corridor do not substantially alter this description. "The proposed road alignment begins on the north bank of the Kuskokwim River between Upper and Lower Kalskag and closely parallels the western flank of the Portage Mountains to Paimiut Slough, off the Yukon River, roughly a distance of 33 miles (Figure 2-2 a/b).

The alignment crosses a low terrace of the Kuskokwim River (within the 100-year floodplain) for the first 1.1 miles. The soils report for the Kalskag School Site (FSD RK _ 17) indicates that the Corps of Engineers 100-year flood in this vicinity will be at an approximate elevation of 97 feet from the assumed datum of 100 feet at the (old?) schoolhouse used in the Kalskag school site report. Correlating the assumed datum to topographic mapping performed for the Yukon-Kuskokwim portage road study results in a 100-year flood elevation of about 56 feet. Thus the 100-year flood could inundate this first section of the alignment to a depth of about 10 feet.

From the Kuskokwim River floodplain, the alignment rises over a low erosional escarpment onto the silt fan apron along the west flank of the Portage Mountains. With the exception of several short sections near the north end of Arhymot Lake, the alignment remains on the apron to about milepost 25. During selection of this portion of the alignment, careful consideration was given to maintaining minimum road grade and cross-slope while attempting to keep the centerline as high as possible on the fan apron where soil foundation conditions and culvert placement were assumed to be more favorable. Over this portion of the alignment (Milepost 1.5 to milepost 25) there is a choice between routing along the flatter fan apron or along the undulating foot slopes of the Portage Mountains. The fans are expected to have somewhat poorer foundation soil conditions (silty soils and high ground ice content) but grades would be nearly flat and cuts would be uncommon. Conversely, routing along the foot slopes may provide better foundation conditions over better drained bedrock derived soils but, grades would be more difficult and thicker fill or undesireable cuts in ice-rich cross-slope material would sometimes be required with this option. Where other characteristics were similar, flatter alignments were favored over cross-slopes even though somewhat thicker fill sections might be required.

From about milepost 25 to the north terminus on Paimiut Slough, the proposed centerline crosses a portion of the high thermokarst terrace of the ancient Yukon-Kukokwim Delta system. This section crosses what may be an old channel of the Yukon River with a slipoff slope rising towards Paimiut Slough. The current terminus is located on a steep cutbank on the high terrace off Paimiut Slough" (1981 Study).

**Corridors A and B—**These two corridors have not been similarly described as their obvious disadvantages limit their value in terms of comparison to the Primary Corridor. These disadvantages include a lack of existing infrastructure, the additional river distance of their southern termini upriver from both Kalskag and Bethel, the steeper grades associated with location through the Portage Mountains, and northern termini located further upstream on Paimiut Slough.

Figure 2-1a front

11x17

figure 2-1a back

Figure 2-1b front

11x17

figure 2-1b back

Figure 2-2a

- 8 ½ x 11

Figure 2-2b

- 8 ½ x 11

**Corridor Analysis**—Site visits, topographic maps, and aerial photographs were used to evaluate the corridor. Design criteria were established by using the following resources:

- 2005 *Alaska Highway Preconstruction Manual* (PCM), prepared by the DOT&PF
- 2001 *Guidelines for Geometric Design of Very Low-Volume Local Roads* (GDVLVLR), prepared by the American Association of State and Highway Transportation Officials (AASHTO) (2001a)
- 2001 Policy on Geometric Design of Highways, prepared by AASHTO (2001b)

The functional classification of Minor Arterial was chosen for the Primary Corridor because the intended purpose of the roadway is to provide a road capable of hauling fuel and supplies between the Yukon and Kuskokwim River systems. The terrain was classified as "rolling," and vertical grades were set at a maximum of 6 percent.

The design speed of the roadway was chosen to be 40 miles per hour (mph). The roadway design criteria are summarized in Table 1.

The topography of the corridor was evaluated through aerial reconnaissance, and the contour maps and aerial photography were examined to identify an alignment that would limit the magnitude and frequency of grades. Comparisons of steep terrain (grades of more than 6 percent) and gentle terrain (grades of less than 6 percent) were performed to eliminate grades greater than 6 percent.

**TABLE 1**
Roadway Design Criteria

| Design Criteria | Value | Reference |
|---|---|---|
| Functional classification | Minor Arterial | *Policy on Geometric Design of Highways*, Chapter 1 (AASHTO, 2001b) |
| Terrain | Rolling | *Policy on Geometric Design of Highways*, Chapter 3 (AASHTO, 2001b) |
| Design speed | 40 mph | Project Report, WFLHD, 3-25-10 |
| Design vehicle | WB-50 | *Policy on Geometric Design of Highways*, Chapter 1 (AASHTO, 2001b) |
| Lane Width | 12 ft | Project Report, WFLHD, 3-25-10 |
| Shoulder Width | 2 ft | Project Report, WFLHD, 3-25-10 |
| Design volume (2030) | <250 ADT | Assumed |
| Minimum curve radius | 380 ft | *Alaska Highway Preconstruction Manual*, Figure 1120-1 (DOT&PF, 2005) |
| Superelevation | 6% | *Alaska Highway Preconstruction Manual*, Figure 1120-1 (DOT&PF, 2005) |
| Maximum vertical grade | 6% | *Alaska Highway Preconstruction Manual*, Figure 1120-1 (DOT&PF, 2005) |

ADT = average daily traffic
WFLHD = Western Federal Lands Highway Division

## 2.2 Route Design Options

**Single Lane Heavy Haul Road with Turnouts—**A concept that could reduce project costs as well as reduce the footprint of a heavy haul road is construction of a single lane gravel road with intervisible turnouts to accommodate two-way traffic. For a two lane road 28 feet wide (12-foot lanes and 2-foot shoulders) with a 5-foot-thick embankment, a single lane road could reduce embankment quantities by up to 23 percent. This quantity saving would be reduced by the quantity needed for slow-moving vehicle, intervisible turnouts spaced at a minimum of every 1,000 feet. These turnouts would be 12 feet wide and 100 feet long with the appropriate 25:1 tapers in and 50:1 tapers out. This is the equivalent of approximately 18 miles of additional lane width over a 33-mile-long project, shrinking the saved quantities to about 8 percent. Offsetting this quantity saving is the difficulty in managing equipment while constructing a single lane road. Hauling units will be passing each other continuously while traveling to and from a given material source. Having to use the turnouts during construction will increase the initial capital cost. The largest disadvantage with this model is the long-term loss of utility associated with a one lane road once completed. Even vehicles of modest width, such as pickup trucks pulling boat trailers, would be obliged to use the turnouts, and longer trip times for commercial hauling becomes costly. Considering the above, this option will not be advanced for further analysis (Figure 3-5).

**Heavy Haul Road with North End Canal—**The north end of the project traverses the Yukon-Kuskokwim Plain (thermokarst) for 6 to 8 miles. The plain is poorly drained and likely consists of ice-rich silt that which would provide poor foundation for a heavy haul road, resulting in a significant level of on-going maintenance. A concept identified to relieve this situation is construction of a canal from the Yukon River to the flanks of the Portage Mountains where roadway foundations are much stronger. However, considering the topography of the area, a canal would need locks to lift or lower barges in accounting for the 50- to 60- foot elevation differential between Paimiut Slough and the Portage Mountains. Additionally, the fact that this entire 6 to 8 miles lies within the Yukon Delta National Wildlife Refuge, coupled with the requirement for a National Environmental Protection Act (NEPA) document (likely an Environmental Impact Statement [EIS] that would attract national attention), suggests a time line that is incompatible with the project purpose. Considering also that "the alteration of the subsurface thermal regime leading to massive degradation of permafrost," coupled with a 1981 estimated cost of approximately $10 million/mile, leads to dismissal of this option (1981 Study). Note that it would also take a barge an additional hour to travel the 6 to 8 extra miles, whereas a road vehicle would cover the distance in about 15 minutes (Figure 3-5).

**North Option—**A North Option for the heavy haul road was developed through the use of U.S. Geological Survey (USGS) Quad maps and aerial photography. This option has not been field-verified, as has the Primary Corridor. This option departs the Primary Corridor near the north end of the Portage Mountains, heading northeast along the flanks of the Portage Mountains until it passes the eastern boundary of the Yukon Delta National Wildlife Refuge. It then heads generally north across the high thermokarst terrace of the ancient Yukon-Kukokwim Delta system to Paimiut Slough. The option adds approximately 7 miles to the Primary Corridor length. The primary advantage of this option is relocation of the Paimiut dock and it's staging area from inside to outside of the refuge. Also the roadway portion of this option that does fall inside the refuge is now located along the flanks of the mountains rather than in the refuge wetlands.

**Twelvemile Slough Option**—Understanding that the northern 6 to 8 miles of the proposed alignment presents the most difficulty in terms of permitting, design, and construction, an option to locate the northern terminus on the Twelvemile Slough was examined. The primary advantage would be a shorter length of roadway traversing the thermokarst between the Portage Mountains and a waterway connected to the Yukon River. However, anecdotal evidence provided by the Denali Commission suggests that neither Twelvemile Slough nor any of its tributaries are navigable except periodically during higher water events. The slough is not considered navigable by the size of vessels necessary for transporting significant quantities of bulk fuel to supply communities along the Kuskokwim River system. This option is further complicated by its location within the Yukon Delta National Wildlife Refuge from an environmental and permitting perspective.

## 2.3 Land Status

Alaska has a complex system of land management as a result of the various land laws that have provided entities with rights to Alaska lands. These laws include the Native Allotment Act, Alaska Statehood Act, Alaska Native Claims Settlement Act, Alaska National Interest Lands Conservation Act, and Municipal Entitlement Act (1978). The Primary Corridor begins on privately owned lands moving almost immediately into Native Corporation-conveyed lands before entering the Yukon Delta National Wildlife Refuge managed by the U.S. Fish and Wildlife Service (USFWS). Land status in the project area is shown in Figure 2-3 a/b. Table 2 provides the estimated acreage required for the project from each of these entities.

Figure 2-3a

8 ½ x 11

Figure 2-3b

11x17

Figure 2-3b back

**TABLE 2**
Land Ownership and Estimated footprints (acres)

| | YDNWR | Sate | BLM | Private | Native Corp. | Total |
|---|---|---|---|---|---|---|
| **Primary Corridor** | 206 | 0 | 0 | 12 | 182 | **400** |
| **Material Sources** | 100 | | | 75 | | **175** |
| **Docks** | | | | **20** | | **20** |

**Note:**

Roadway footprint widths of 100 feet for gentle terrain, 17 miles in refuge, 15 miles in Native Corporation conveyed, and 1 mile in private sector.

Estimated 7 material sources at 25 acres per source, 3 outside the refuge. Estimated 2 docks at 10 acres each.

## 2.4 Existing Utilities

There is no water distribution or treatment system serving Lower and Upper Kalskag. The school, the store, and nearly all homes have individual wells and indoor plumbing. Sewage collection, provided by the City, consists of a piped gravity system with lift stations, a forced main, and lagoon. Individual and community septic tanks are also in service. Electricity, diesel fired, is provided by Alaska Village Electric Cooperative (AVEC). Communication services are provided by Bush-Tell, Inc. (in-state telephone) and AT&T Alascom (long-distance provider). Internet service is provided to the school by GCI. One television station, ARCS, and two radio stations, KYUK-AM and KICY-AM, serve the communities.

No utility conflicts are expected in association with project development. Electricity will need to be provided to the southern terminal and power for the northern terminal will be provided by a modest local generator.

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SECTION 3

# Preliminary Engineering

## 3.1 Geotechnical Engineering and Materials

### Geologic Setting and Hazards

The proposed route generally follows the west edge of the Portage Mountains. As seen in Figure 3-1, the Portage Mountains are generally comprised of Mesozoic and Paleozoic volcanic rock. Additionally, both the 1981 Study, and later field visits found that there are several felsemeer slopes that suggest shallow bedrock near the proposed route. Further to the west, there are silt fans that have been created by numerous mountain streams. The majority of the proposed route, like the 1981proposed route, is along the east edges of these silt fans. The 1981 Study notes that while these fans are similar to alluvial fans, they are "most probably composed entirely of frozen organic silt, generally ice –rich, that has been retransported by slope wash." The silt fans, in effect, form an apron over the alluvial plain of the Yukon-Kuskokwim Delta. This plain is, according the 1981 Study, "composed largely of freshwater alluvial silts and fine sands with considerable organic content." The proposed route then leaves the western edge of the Portage Mountains, and heads towards the Yukon River crossing over this plain. The very northernmost and southernmost portions of the proposed routes are above the relatively recently formed Yukon River and Kuskokwim River floodplains, which are "underlain by well sorted alluvial sands and gravels."

According to information presented in the 1981 Study, it is very likely that the proposed route will run above permafrost. While further subsurface exploration would be necessary to confirm this, the study notes that "periglacial and thermokarst features are ubiquitous."

For the majority of its distance, the proposed route has been placed along the upper edges of the silt fans. This generally brings more favorable route positioning for culvert placement. Additionally, the soils found further up the hillsides are generally better able to support a roadway. These two points are counterbalanced by the need to maintain a fairly level grade, and the need to reduce cuts as much as possible. Reducing the amount of cut along the route is important so as to minimize impact on the thermal regime of the permafrost below the roadway. The Primary Corridor depicted in Figure 3-1has been located to balance these four important factors.

### Material Sources

As shown in Figure 3-2, several potential material sources have been identified along the route. It is important to note however, that their usability must be confirmed with further subsurface exploration. The sites that have been identified generally fall into one of three different categories: alluvial sands and gravel along the Kuskokwim River, felsenmeer along the west edge of the Portage Mountains, and alluvial sands along the Yukon River's Paimiut Slough. Additionally, there may be some capacity remaining at the Upper Kalskag pit.

Near the north portion of the alignment, the 1981 report uncovered non-frost susceptible sands underneath about 12 feet of silt. The most promising of these deposits are on the north side of the Paimiut Slough. It was also noted that there is a large sand dune about a mile north of the northern terminus, but that it may be too silty for use as anything other than unclassified borrow.

The central portion of the proposed route is generally near felseenmeer formations. This could indicate that bedrock is at a fairly shallow depth. During the field investigation for the 1981 Study, the authors noted that the rock samples "were very hard, porphyritic, very fine grained, and occasionally glassy." This rock may yield suitable material, but could require blasting even at shallow depths.

The north portion of the proposed route, just to the south of Paimiut Slough is the longest portion of the project without any suitable material sources. Further investigation may identify another suitable material source near the north end of the Portage Mountains. If not, material will need to be transported to this location.

#### Upper Kalskag Quarry

An existing quarry rock source is located about 1.4 miles north of Upper Kalskag. It is owned by Calista Corp. and managed for them by Knik Construction. According to a "Geotechnical Report, Kalskag Airport Reconstruction, July 1999," prepared by the State of Alaska Department of Transportation and Public Facilities (DOT&PF), the quarry "is currently being mined for both pit run and crushed rock. The rock at this site is currently being ripped. Harder material is reported at the quarry and may require drilling and shooting. The quarry shows a highly fractured and jointed igneous intrusive rock with weak, very weathered zones. A sample of the more competent rock had an LA Abrasion value of 16 and a Degradation value of 33, while a sample of the weak, very weathered rock had an LA Abrasion value of 18 and a Degradation value of 1."

Conversations with Knik Construction representatives confirm that the harder material does need to be drilled and shot and that the softer seams within the hard rock make it difficult to control the quantity of material retained on the #200 sieve. Test results, provided by Knik Construction, on crushed aggregate produced in the quarry in 2010 show degradation values ranging from 20 to 79 with an average of 21 samples being 52.

The existence of this quarry in the Portage Mountains suggests that additional sites north along the proposed roadway corridor could contain comparable deposits. Additional subsurface investigation would be needed to confirm the quality and quantities of available materials in the vicinity. Knik Construction representatives also indicated the presence of a sand pit on the south side of the Kuskokwim River near Akiak, as well as sources of varying quality and quantities near the communities of Bethel, Platinum, and Goodnews Bay.

#### Additional Material Sources

The previously-mentioned Geotechnical Report for the Kalskag Airport also describes exploration of two potential gravel sources along the north side of the Kuskokwim River:

> "The first site is an existing gravel bar along the north side of the Kuskokwim River approximately 0.4 km upstream from Upper Kalskag. The three test pits dug on this bar found sandy gravel and gravelly sand with an estimated

> 5 percent of cobbles up to 150 mm in diameter with the rest of the material less than 37.5 mm in diameter. The sandy gravel/gravelly sand had P0.075 values of 1, 0, and 5. A combined sample was tested and found to have an LA Abrasion value of 15 and a Degradation value of 69. The second site is an existing gravel bar along the north side of the Kuskokwim River adjacent to Lower Kalskag. The three test pits dug on this bar found sandy gravel with an estimated 5 percent of cobbles up to 125 mm in diameter with the rest of the material less than 37.5 mm in diameter. All three samples of the sandy gravel had a P0.075 value of 1. A combined sample was tested and found to have an LA Abrasion value of 15 and a Degradation value of 77."

The DOT&PF has recently completed another material site investigation, the "Marshall Material Site, March 2010". Although this site (Pilcher Mountain Material Site) is approximately 110 river miles downstream along the Yukon River from Paimiut Slough, it may be a suitable site for providing the initial lift of material for the north 6 to 8 miles of the proposed roadway alignment as well as the initial lift for a 5 acre port site. Crushed aggregate products could also be produced at this site.

The Pilcher Mountain Site, located on land jointly held by Calista Corp. and Maserculiq, Inc. is undeveloped. From the report:

> "The vegetative layer and brown organic silt found up to 3-ft in depth, must be considered as unusable. The gray and weathered bedrock with silt, found in the 2-ft to 10-ft overburden interval, immediately above the competent bedrock will, depending on processing, pass standard specifications for Select Material, Type C and Airport Embankment. Based on observed boulders in the material site used for the access road and the lengths of unbroken core from our drilling, this proposed material site could, depending on processing, be a source for Class I or Class II Riprap. The potential for larger riprap is not known.
>
> The area circumscribed by the five adjacent test holes, amounts to approximately 20,000 square yards. These holes encountered an 11-yard to 12-yard thickness of high quality rock and bottomed in this material. The drilling therefore conservatively defined an indicated resource of 225,000 cubic yards of material we anticipate will meet standard quality specification for Airport and Highway crushed aggregate products."

The report further states that the overall "potential available resource, at this site, could exceed 700,000 cubic yards". Test results show LA Abrasion values ranging from 13 to 24 and Degradation values ranging from 51 to 93.

Should this site be developed, it could provide access to the quality of material desired for roadway surfacing without having to rely on either relaxed specifications or long, expensive transportation (from, for example, the quarry near Nome).

#### Mining and Placement Recommendations

Quantities for Unclassified Borrow, Aggregate Base, and Aggregate Surface Course have been estimated at 4,230,000 tons, 790,000 tons, and 197,000 tons, respectively. While it is conceivable that as much as 300,000 cubic yards of material could come from the Kalskag

Quarry, the haul distance suggests that additional material sites at approximately 10-mile intervals would be more cost-effective. This would depend on material source and access road development costs. Many factors need to be considered in planning for providing construction materials for a new, 33-mile-long road. For example, material sources available along the proposed route, while perhaps present, may not be the most economical to develop. They may require excessive digging, lie significantly under the water table, or be on the wrong side of a river like the alluvial sands near the termini of the proposed route. The material may also require expensive blasting. With these factors in mind, it may be more economical to utilize already developed material sources such as the pit at Upper Kalskag, or other developed pits along the Kuskokwim and Yukon Rivers. The disadvantage to this is additional transport cost. It is also possible that depletion of existing pits for construction of this project may not be considered the best use of the material. Only further subsurface exploration and analysis of the potential material sites along the proposed routes will be able to determine how much of each method would be the most cost effective.

Consideration should also be given to additional subsurface investigation along the proposed route in support of a “balance” project, whereby the useable excavation quantities balance the embankment quantities, thereby reducing the need to identify and develop additional material sites.

Figure 3-1

11x17

Figure 3-1 back

Figure 3-2

8 ½ x 11

# 3.2 Hydraulic Engineering and Drainage Structures

### Floodplain Issues and Impacts

The proposed route in both this analysis and the 1981 Study is well outside of the Yukon River and the Kuskokwim River floodplains, except for a few miles near the north and south termini. Construction in the floodplain in these areas is unavoidable for this route. In the north, near the Yukon River, the roadway would be constructed on a bluff that is significantly higher than the non-flood river elevation. While the docks at this terminus would obviously be affected, the route would be protected by the bluff, apart from very significant flooding events. The south terminus of the proposed route is more susceptible to flooding, as it has no significant bluffs or other natural features to protect it from high water. As the 1981 Study reports, "the 100 year flood plain could inundate the first section to a depth of about 10 feet."

As there is no way to entirely remove the termini of the proposed route from the river floodplains, a flood mitigation plan may be prudent to plan and facilitate repair or replacement of damaged roadway following high water events.

### Stream Crossings and Roadway Drainage

The Primary Corridor crosses many streams. The majority of these are encountered in the segment on the western flank of the Portage Mountains. Some of these streams may be intermittent, but culvert crossings should be considered for all of them. As seen on Figure 3-3, there are approximately seven major stream crossings, with a tributary area between 0.1 square miles and 2.8 square miles. Using flood frequency information from the *Magnitude and Frequency of Floods in Alaska and Conterminous Basins of Canada, US Geological Survey* and USGS climate data from nearby Aniak, 25-year flood flows for these major stream crossings were calculated to be between 15 and 300 cubic feet per second. As these findings approximately match the 1981 Study, the culvert requirements laid out in that document are still valid.

In addition to the seven major stream crossings, there are many smaller, likely intermittent, drainage crossings. Again, these are mostly present along the west edge of the Portage Mountains. These drainages have eroded the surrounding soil in many places and require culverts sized to accommodate occasional larger flows. More than 100 drainage areas and more than 200 drainageways were identified. An analysis of the proposed route yields similar quantities and confirms that the data presented in the 1981 Study is still valid.

While this analysis, as well as the analysis presented in the 1981 Study, should not be considered as a culvert design for the proposed corridor, the data is useful for obtaining approximate sizes and quantities for reconnaissance level cost estimating. The 1981 Study presents 168 culverts between 12 and 24 inches, 22 culverts that are either 30 or 36 inches, 10 culverts that are either 42 or 48 inches, and 6 culverts that are greater than 48 inches in diameter. Given that all of the data used to calculate culvert sizes and quantities have been approximately verified, the enumeration presented in the 1981 Study still holds true for this report. However, a minimum culvert diameter of 24 inches is now recommended as consistent with design of a minor arterial highway, except for the 18-inch relief culverts proposed where ice damming is predicted. This situation is discussed below.

Figure 3-3

8 ½ x 11

### Ice Damming

The culvert analysis presented above did not take into account reduced flow from ice damming. In the event that ice does indeed plug a culvert, the roadway at that location may be washed out with any spring runoff. In order to mitigate that possibility, the 1981 Study undertook an extensive analysis of each drainage basin, comparing them with several factors that influence ice damming. These factors include a south or southwest facing slope, a concave slope, a steep slope or nearby break in slope, and shallow stream flow.

For the 25 drainages that were determined to have a high probability of ice damming, the authors of the 1981 Study recommended placing additional 18-inch culverts just above the primary culverts, in order to take the flow that would otherwise be travelling in the ice-blocked culvert below it.

## 3.3 Roadway and Design

This section identifies potential roadway design, material sites, and geotechnical issues associated with design and construction of a heavy-haul road along the proposed route between the Yukon River and the Kuskokwim River. Additional surface and subsurface exploration will be needed to further verify and quantify these issues.

### Design Criteria

In order to develop an adequate idea of the potential roadway route and section, along with the associated costs, some general design criteria have been developed. These criteria generally ensure that the roadway would be able to be used as a haul route for transporting cargo between the Yukon and Kuskokwim Rivers (see Table 3).

**TABLE 3**
*Design Criteria*

| Criteria | Selection |
|---|---|
| Road Type | Minor Arterial (Heavy Haul) |
| Lane Width | 12′ |
| Shoulder Width | 2′ |
| Design Vehicle | WB-50 |
| Design Speed | 40 mph |

### Design Features

The Primary Corridor was selected based on information from the 1981 Study, additional mapping information, and a reconnaissance trip that involved flying over the entire route, landing at select locations, and analyzing potential route improvements.

Generally, the 1981 alignment was located based on three broad factors: (1) the proximity of the Yukon and Kuskokwim Rivers to each other, (2) the existence of infrastructure in the Upper and Lower Kalskag communities, and (3) relatively strong foundation afforded by the Portage Mountains foothills.

More specifically, the resulting alignment, located on the westside foothills of the Portage Mountains, takes advantage of the stronger foundation offered by upland terrain over the more marginal foundation conditions expected to be found in the thermokarst plain immediately to the west. This thermokarst—by definition expected to be underlain by relatively warm, discontinuous permafrost—would likely further degrade should the thermal regime be altered by construction of a new road. Unfortunately, avoidance of the thermokarst on the north end of the proposed project is virtually impossible; techniques to minimize impact to the thermokarst are discussed below. The 1981 study notes the added benefit to locating the road in the upland terrain in the avoidance and minimization of impacts to migratory bird nesting and rearing habitat within the Refuge.

The Primary Corridor generally follows the west side of the Portage Mountains. It begins in the south at the north bank of the Kuskokwim River, between Lower and Upper Kalskag. The route then heads northwest approaching the flank of the mountains until it is out of the Kuskokwim floodplain. The route then follows the west side of the Portage Mountains for approximately 24 miles, generally remaining on the lower edge of the mountains and above the elevation of the nearby plains. Near the northern end of the route, the roadway must turn away from the sides of the Portage Mountains and follows what appears to be an ancient channel leading toward the Paimiut Slough. Except for the termini, the alignment is wholly outside of the Yukon River and the Kuskokwim River 25-year flood plains.

See Figure 3-4 for a graphical representation of the route.

### Roadway Section

The roadway section was selected, and subsequently refined, based on information presented in the 1981 report and data from the Western Federal Lands Highway Division (WFLHD) Project Report specifying a two–lane, heavy haul road and its associated design criteria. This information is not intended to be a firm roadway section design, as there have not been sufficient soil investigations along the route. Instead, this information is presented to make a preliminary cost estimate for the proposed route.

The top layer proposed is an aggregate surface course that varies from 6 to 12 inches in depth, depending on the quality of the material along the proposed route. The next layer is to be an aggregate-base course, where the total depth of the section again varies, this time depending on the foundation conditions along the proposed route. The final layer is comprised of unclassified borrow, used to bring the roadway surface up to the desired design grade, as well as to adjust the embankment thickness to compensate for differing subsurface conditions along the route.

Because of a lack of additional field work, many of the material recommendations have been taken from the 1981 Sudy, and modified to meet the criteria of this analysis. See Figure 3-5 for a schematic view of the above-described section. Note that embankment side slopes are 4:1 rather than the 2:1 shown in the 1981 Study. Additionally, a geogrid material could be useful in selected embankment locations to help mitigate the effects of thaw settlement.

Additional techniques for road construction in areas of discontinuous permafrost have been developed and tested over the past 30 years. The common goal is to cost-effectively maintain the existing subsurface thermal condition directly under the newly-constructed roadway prism, thus reducing or controlling embankment and surface deformation and subsequent maintenance costs. These techniques include:

- Construction of stabilization berms abutting the roadway embankment to limit thaw to the ground under the berm rather than under the road; drawbacks include an increased footprint and additional load on a likely weak foundation
- Open cooling tubes placed parallel to the ground that allow the foundation to refreeze during the winter – the tubes are capped during the summer; drawback is the cost for installations beyond those at relatively small, site specific locations
- Vertical thermosyphon tubes placed adjacent to the toe of the embankment to keep the underlying ground frozen; drawback is the cost for installations beyond those at relatively small, site specific locations
- Placement of insulation or geofoam on the ground prior to placement of embankment; drawback is the cost of insulation for large applications and the fact that insulation slows, but does not stop, heat transfer
- Use of lightweight fill, such as wood chips, to minimize the load on weak foundations; drawback is difficulty in obtaining an inexpensive material that is lightweight, resists water absorption, and has insulation properties
- Placement of an initial layer large angular rock to encourage heat dissipation in the summer and refreezing in the winter; drawbacks include difficulty in identifying suitable material sources and the cost of drilling and shooting the rock

This last technique appears to show the most promise and has been refined over the past several years by the University of Alaska, Institute of Northern Engineering and is documented in the Air Circulating Embankment (ACE) Design Guide, February 2009. An ACE is a roughly 5-foot-thick embankment constructed of coarse, uniformly graded rock 8 to 9 inches in diameter. The intent is to create voids, particularly in the vertical direction, that encourage air circulation (essentially convection currents) that will ultimately reduce the temperature of the underlying, relatively warm, permafrost foundation. The subsequent cooling of the foundation will reduce, perhaps even prevent, thermal degradation and surface deformation. This installation includes a strong geogrid placed under the rock and a strong separation fabric placed on top of the rock which is in turn covered by a nominal 1- to 2- foot-thick wearing course.

Each of these techniques has demonstrated some success. However, a recommendation/decision to use a given technique would depend on the results of further geotechnical investigation to determine existing subsurface conditions as well as identification of suitable material sources capable of producing large angular rock.

Conversations with State of Alaska DOT&PF staff in the Northern Region confirm the selected use of these techniques and the difficulty of cost-effectively applying any one of them to long stretches of roadway embankment. The ACE construction technique could be an exception, should ample quantities of suitable rock be discovered and exploited in the Portage Mountains adjacent to the project.

Figure 3-4

8 ½ x 11

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Figure 3-5
11x17

3-5 back

## Construction Requirements

**Logistics and Mobilization**

Lower and Upper Kalskag are located on the north bank of the Kuskokwim River, about 90 miles upriver from the regional hub of Bethel in Southwest Alaska. The two communities are joined by a 2-mile-long gravel road. The Kalskag Airport, located between Lower and Upper Kalskag, has a 3,200-foot by 75-foot gravel runway and is served by two flying services, as well as charter aircraft. Satellite imagery indicates suitable barge landing ramps at both communities. A winter ice road connects Bethel to Aniak along the Kuskokwim River, providing relatively easy seasonal "land" access to the area from Bethel.

This will be a large construction project requiring mobilization of a significant equipment fleet, a personnel camp, maintenance facilities and fuel. Mobilization of all heavy equipment and bulk materials would be on barges up the Kuskokwim River to the Kalskag area during the summer, or via the ice road in the winter/early spring, ideally to the selected dock location and staging area. Personnel and incidental supplies would mobilize to the Kalskag area via modest aircraft to the Kalskag airport. Some equipment, materials, and personnel could be mobilized by barge via the Yukon River to the Paimiut dock location but the total lack of infrastructure is a significant drawback to this option. An exception could be made for driving sheet pile for the Paimiut dock which could possibly be completed by barge.

Although construction contractors develop their staging and building plans based largely on the make-up of their individual equipment fleets, a construction scenario can be envisioned that is focused on minimizing impacts to the local community and avoiding depletion of the local material source in Kalskag. Equipment could be mobilized in the late winter/early spring from Kalskag via a new ice road to the first material source along the alignment (approximately 5 miles) in the Portage Mountains. Development of the pit could include construction of a modest personnel camp supplied via the ice road. A more permanent pioneer road would be constructed on the roadway alignment both directions from the pit – back toward Kalskag, and ahead to the next material source. With pioneer roads connecting material sources and a supply center in Kalskag, a contractor has the freedom to complete roadway sections, and the Kalskag dock, as he sees fit. A contractor could mobilize an initial pioneer crew and equipment, followed by a production crew and equipment once initial access has been provided and material sources have been developed. Demobilization would reverse this process with removal of production equipment followed by the finish and clean-up crew.

**Seasonal Work Timing**

Generally, seasonal work timing issues include the pros and cons associated with winter versus summer mobilization and/or construction, work restrictions because of migratory bird nesting and rearing windows, and in-stream work restrictions related to fish spawning and migration.

Mobilization of equipment, fuel, camp facilities, and supplies to and from the Kalskag area can occur during the summer by barge when the Kuskokwim River is ice free between June and October, assuming normal flow volumes. Use of the Kuskokwim in the winter is also possible via ice road, although extreme winter temperatures inhibit use except in early spring prior to river break-up. Mobilization of personnel, supplies, and small equipment can be managed by air through regularly scheduled air carriers or larger charter aircraft. Air travel is available both summer and winter.

Most construction activities occur during summer months, although some activities benefit from the frozen ground of late winter or early spring to support heavy equipment. Such activities include hydro-axe clearing and placement of geogrids and initial embankment layers that will be capable of supporting equipment during the summer season. Summer construction is also advantageous due to the long daylight hours.

Seasonal environmental constraints also affect construction timing. Migratory bird nesting and rearing windows will be identified in the appropriate environmental document. Contractors often hasten to clear an alignment prior to nesting and will sometimes cover the cleared ground with plastic sheeting to prevent nesting and rearing while preparations are made to place embankment materials. Nesting and rearing windows are serious considerations, as they can interrupt construction activities for up to 2 spring/summer months.

In addition, seasonal construction can be influenced by restrictions to in-stream work because of fish windows set by resource agencies such as the State Department of Fish and Game and/or USFWS. These windows, typically identified for specific species of fish in the projects' environmental document, will specify calendar dates when in stream work is either prohibited or restricted and will sometimes impose turbidity limits as well. Again, these are serious considerations that should be integrated into a contractor's construction schedule.

It is expected that a project of this magnitude would take two full construction seasons, assuming that adequate materials can be obtained proximate to the project. Should additional materials need to be barged in, construction could take an additional season. Material availability is further discussed below.

**Erosion and Sediment Control**

A project level Storm Water Pollution Prevention Plan will be developed during the environmental phase of the proposed project. This plan will be refined by the contractor for agency approval prior to initiation of any ground disturbing activities. It will need to address erosion and sediment control associated with dock construction adjacent to Paimiut Slough on the north end of the proposed project and the Kuskokwim River on the south end, full-length roadway construction on both sides, and material source and access road development and exploitation.

The plan will need to be developed, implemented, and continuously monitored during construction. A significant level of scrutiny should be expected due to proximity of the proposed project to the Yukon Delta National Wildlife Refuge. Given the relatively straightforward nature of the anticipated construction, these plans and their implementation should be relatively simple, involving sediment wattles and/or silt fences in any fill conditions and ditch protection in the few cut conditions present. Embankment construction across the Yukon Kuskokwim Plain will require best management practices to be implemented full lengths along both sides and turbidity limits should be expected in the vicinity of Paimiut Slough and the Kuskokwim River.

**Borrow / Waste Areas**

There are several sites that could be suitable for borrow along the proposed route. Several of these sites were identified in the 1981 report. See Figure 3-6 for locations of sites that may contain appropriate types and quantities of materials to be used for the proposed route. These sites fall into three separate categories, sands and gravels along the Kuskokwim near Kalskag, bedrock and rubble deposits along the Portage Mountains, and sands along the Yukon River. As the majority of the roadway is in a fill condition, any excavated inorganic material, depending on its moisture content, will be used for unclassified borrow in the roadway embankment, reducing the need for imported borrow. Organic waste will be stockpiled for use in covering exposed slopes, aiding in re-vegetation with local plants, shrubs, and trees. Excess excavation deemed unsuitable for embankment construction will be placed in specifically-located upland waste berms adjacent to the proposed road.

Material source stripping will also be stockpiled for future use in rehabilitation of the sources. Given the locations of potential material sources identified to date, it is likely that materials will need to be transported a significant distance along the proposed route. This may result in increased construction costs and construction duration over similarly sized projects elsewhere. Again, further investigation should be initiated to locate a suitable source near the north end of the Portage Mountains.

# Figure 3-6

## 8 ½ x 11

### Transfer Facilities

A significant portion of the proposed project cost will be in developing port facilities to transfer goods from the river barges to trucks that will traverse the proposed route. The 1981 Study notes that the dock design in use at Bethel should be appropriate for both termini. Extrapolating the Bethel dock design to the locations on the Paimiut Slough and the Kuskokwim River would mean constructing either two 60-ft diameter sheet pile cells, or one larger cell, and up to four hundred feet of bulkhead per dock.

The port facility on the Kuskokwim River could be placed just south of Upper Kalskag, between the town and the airport, where approximately 6 acres of undeveloped land exists. This land and access to it from the north is owned by the State of Alaska, the City of Upper Kalskag, or the Kuskokwim Corporation.

The dock on the Paimiut Slough can be built just east of Twelvemile Slough. The bank at this location is fairly high, requiring some reconstruction so that the proposed route can meet the elevation of the dock. The land in this area will need to be purchased from private interests unless the North Option is selected, but there is no current development at either location.

As Norman Stadem describes in his March 2010 report, the design is sound and can be scaled up to reflect increased construction costs. Assuming an initial upland area development of only 5 acres per port, expandable to a future 10 acres per port, the cost of $15 million per facility is a reasonable reconnaissance level estimate.

Modern fuel transfer facilities (2003) exist in Kalskag along with tanks for bulk storage of approximately 127,000 gallons of fuel. Fuel transport companies can push barges up to 120 feet long, carrying about 150,000 gallons of fuel on the Yukon and Lower Kuskokwim Rivers. It is assumed that barges half this size and capacity would be needed to navigate Paimiut Slough and the upper Kuskokwim River. A storage facility for 75,000 gallons of fuel would need to be constructed on the north end of the project at Paimiut Slough. The fuel would be transferred to the Kalskag facility via trucks with carrying capacities of 5,700 to 9,200 gallons, resulting in 13 to 8 truck loads respectively to transfer a barge load of fuel from the Yukon River to the Kuskokwim River. Assuming a round trip of about 3 hours per truck, using two trucks, it would take 12 to 21 hours depending on truck capacity.

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SECTION 4

# Environmental Considerations

## 4.1 NEPA

NEPA requires identification, disclosure, and mitigation of potential adverse impacts associated with construction of federally-funded projects. In this case, given that over half of the project (about 17 miles) falls within the Yukon Delta National Wildlife Refuge, an EIS will likely be the level of documentation required by the agencies involved. The expected lead agency would be the US Fish and Wildlife Service as manager of the refuge with the US Army Corps of Engineers acting as a cooperating agency considering that approximately 7 miles of the new alignment will likely impact wetlands on or near federal lands. The NEPA document will be developed in accordance with the Federal Highway Administration Technical Advisory 6640.8A (1987), which provides guidance on preparation of environmental documents for compliance with the National Environmental Policy Act (NEPA). See Appendix B for additional environmental considerations.

The refuge boundaries were extended to include much of the project area, as well as the traditional portage routes, in 1980 with passage of the Alaska National Interest Lands Conservation Act (ANILCA, Public Law 96-487). Acquisition of a right-of-way (ROW) or an easement through the refuge will be a significant unknown in terms of scheduling further project development. There are two known mechanisms for addressing access across federal conservation system units. The State can initiate a process to assert its access rights through a public law known as RS2477 or through Title 11 of ANILCA. Initiation of either process will be time consuming with no up-front guarantee of success.

## 4.2 Local Issues

Several issues specific to the project area have been previously identified and will need to be addressed during the NEPA documentation process as well as the federal, state, and local permitting processes (see Table 4 for a listing of potential permits). Foremost among these issues relate to the human environment in the form of concern regarding potential project effects on subsistence resources, the need for local hire and training for both construction and maintenance of the project, and protection of property rights. Different communities expressed their own unique perspectives at public meetings, conducted in 1981, with Kalskag residents favoring the project as long as these concerns be considered and they be advised of project progress and allowed continued input. Holy Cross residents and representatives from Shageluk, Anvik, and Grayling were unanimous in their opposition to the project, based entirely on concern for the project's potential effect on the area's subsistence resource, specifically the moose population along the Yukon River. Again, these concerns and opinions were voiced in 1981 and, although the issues may remain, the emphasis and priorities may have evolved.

Several issues pertaining to the natural environment will need to be addressed in the NEPA document as well. The most obvious issue concerns the wetlands of the Yukon-Kuskokwim delta crossed by the alignment on the north end and the attendant migratory bird population that nest and rear their young in and near the Yukon Delta National Wildlife Refuge.

**TABLE 4**
*Potential Federal and Local State Permitting Requirements*

| Regulated Activity (Required Permit/Approval) | Regulatory Agency | Authority | Description |
|---|---|---|---|
| Federal Authority | | | |
| Discharge of dredged or fill material into U.S. waters including wetlands (Section 404 Permit). | USACE | Section 404 Federal Water Pollution Control Act of 1972, as amended in 1977 (Clean Water Act) (33 USC 1344) | The USACE must authorize the discharge of dredged or fill material into, and excavation in, U.S. waters, including wetlands. The USACE determines compliance with the Section 404 (b)(1) guidelines. |
| Discharge of dredged or fill material into U.S. waters including wetlands (review of U.S. Army Corps of Engineers (USACE) Section 404 Permit). | EPA | Section 404 Federal Water Pollution Control Act of 1972, as amended in 1977 (Clean Water Act) (33 USC 1344) | EPA reviews (USACE) Section 404 Permit under its Section 401(b)(1) “Guidelines for Specifications of Disposal Sites for Dredged or Fill Material.” |
| Any construction activity that is exposed to storm water (NPDES storm water permit) | EPA | National Pollutant Discharge Elimination System (NPDES) | EPA must permit construction activities that disturb more than one acre of ground and are exposed to storm water. |
| Any federal project requiring an EIS (Subsistence Evaluation) | FHWA | Section 810, ANILCA of 1980 | Any federal agency preparing and EIS on a project must analyze the subsistence use of the properties affected and the impact of the project on subsistence |
| Any project impacting federal parkland (4f Evaluation) | FHWA | 49 U.S.C. 1653(f) (Section 4(f) of the USDOT Act of 1966 | The Federal Highway Administration is required to evaluate potential impacts of highway projects on publicly-owned parks, recreation areas, wildlife and waterfowl, refuges, and historic sites. |
| Occupancy and modification of floodplains (Floodplain Management Considerations). | All Federal Agencies | Executive Order 11988 (Floodplain Management) May 24, 1977 | All federal agencies must avoid, to the extent possible, adverse impacts associated with occupancy and modifications of floodplain development, including direct or indirect support of floodplain development, whenever there is a practicable alternative |
| Destruction or modification of wetlands (Wetlands Protection Considerations) | All Federal Agencies | Executive Order 11990 (Protection of Wetlands) May 24, 1977 | All federal agencies must avoid, to the extent possible, adverse impacts associated with occupancy and modifications of wetlands, including direct or indirect support of new construction in wetlands, wherever there is a practicable alternative |
| Any activity occurring in anadromous streams under ordinary high water (EFH | NMFS | Magnuson-Stevens Act (16 USC 1802(10)) | An EFH analysis would be needed for those waterbodies and associated substrate that are necessary to fish for habitat, including spawning, breeding, feeding, or growth to maturity |

**TABLE 4**
*Potential Federal and Local State Permitting Requirements*

| Regulated Activity (Required Permit/Approval) | Regulatory Agency | Authority | Description |
|---|---|---|---|
| Activities that modify stream channels or other water bodies (USFWS consultation) | USFWS | Fish and Wildlife Coordination Act (16 USC 661 et. seq.) | Consultation with USFWS is required to address potential effects on plant and wildlife species and to evaluate measures that may minimize or mitigate those effects. |
| Activities that have potential to affect migrating birds. | USFWS | Migratory Bird Treaty Act | This law prohibits the taking (killing, capturing, hunting, etc.) of migratory birds. |
| Any activity potentially obstructing navigable waters | USACE | Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) | An USACE permit is required when undertaking any work in, over, or under navigable waters of the U.S., or which affects the course, location, condition, or capacity of such waters. |
| Any activity that potentially affects historical or archaeological sites. | ACHP | National Historic Preservation Act of 1966, as amended (16 USC 470) | The Advisory Council on Historic Preservation must be given a reasonable opportunity to review and comment on the adequacy of the management plan for historic or archaeological sites potentially impacted by any federally permitted or licensed project. |
| State of Alaska Authority | | | |
| Any activity that potentially impedes fish passage | DNR-Office of Habitat Management and Permitting (OHMP) | Fishway Act (Alaska Statute 41.14.840) and Anadromous Fish Act (Alaska Statute 41.14.870) | DNR OHMP reviews and issues permits for projects that include activities within or across a stream used by fish if these activities could represent an impediment to the efficient passage of fish. All activities within or across a specified anadromous waterbody and all instream activities affecting a specified anadromous waterbody require approval from the OHMP, including construction; road crossings; gravel removal; mining; water withdrawals; the use of vehicles or equipment in the waterway; stream realignment or diversion; bank stabilization; blasting; and the placement, excavation, deposition, or removal of any material. Activities that affect resident fish are also covered by the Fishway Act and permitting requirements. |
| Activities that require a permit under the Clean Water Act (401 certification) | ADEC | Section 401 of the Clean Water Act (33 USC 1344) | |

**TABLE 4**
*Potential Federal and Local State Permitting Requirements*

| Regulated Activity (Required Permit/Approval) | Regulatory Agency | Authority | Description |
|---|---|---|---|
| Any activity that potentially affects historical or archaeological sites. | DNR-SHPO | National Historic Preservation Act of 1966, as amended (16 USC 470); AS 41.35.010 to .240, Alaska Historic Preservation Act | For any federally permitted, licensed, or funded project, the SHPO must concur that cultural resources would not be adversely impacted, or that proper methods would be used to minimize or mitigate impacts that would take place. Concurrence must be received before federal permits can be granted. |
| Purchase of materials from the State of Alaska | DNR-Division of Lands | AS 38.05; 11 AAC 71.070 through .075 | DNR must issue a Material Site Permit before the removal of borrow material from a state operated quarry site |
| Temporary Water Use/Water Rights | DNR-Division of Mining and Water | AS 46.15; 11 AAC 93 | DNR must issue Water Rights before any appropriation of freshwater from a well, spring, or stream. Temporary use is typically during the construction phase. |
| Activities that could affect endangered species (Section 7 consultation) | USFWS | Section 7 of the Endangered Species Act (16 USC 1531 et. seq.) | Federal agencies must consult with the USFWS to ensure that proposed actions are not likely to jeopardize ethe continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. |

Although moose, black bear, wolverine, lynx and fox have been reported and observed in the area, the project should not impede their movement. There are no known caribou migrations across the project area.

Both the Yukon and the Kuskokwim Rivers serve as corridors for several species of salmon, but no known salmon spawning streams will be affected by the project. These two rivers also contain shee-fish, broad and humpback whitefish, smelt, pike, blackfish, turbot, and least cisco.

The spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*) are known to use a wide range of habitat types located near water, including the Yukon-Kuskokwim Delta. These birds inhabit the delta during the summer breeding season, mid-May to late June. During their breeding season, these diving ducks feed on aquatic insects and plants. The current Endangered Species Act (ESA) status of the spectacled eider is threatened throughout its range (*Federal Register*, May 10, 1993). The ESA status of the Steller's eider is threatened within the Alaskan breeding population (*Federal Register*, June 11, 1997).

"No (other) listed threatened or endangered plant or animal species are known to reside in the project area. The Fish and Wildlife Service reports that the American peregrine falcon nests in suitable habitat on the Kuskokwim River near Aniak, some 25 miles upstream from the proposed Kuskokwim River dock site, and along the Lower Yukon River. None have been observed within the project corridor" (1981 Study). Because these data are 30 years old, they will be verified and updated during the NEPA process. Loss of habitat will be constrained to the footprint of the roadway and dock area as well as ground cover eliminated in development of material sources and waste disposal sites. None of the lost habitat is in short supply in the region.

Turbidity in both the Yukon and Kuskokwim Rivers may be increased during construction of the docks and, although temporary and short-term, will need to be addressed with respect to water quality. Floodplain issues will exist primarily on the south end of the project at the dock site on the Kuskokwim River.

Construction materials will be almost exclusively gravel, rock, and sand mined form sources along the alignment. The committed resources will include approximately 1.25 million cubic yards of material, with the exceptions of steel sheet piles for dock cell construction and steel pipes for drainage culverts along the alignment.

**Construction techniques to mitigate impacts.** Use of state-of-the-art construction materials such as geogrid will be considered as a means of strengthening embankment foundations and reducing embankment quantities and the project footprint. The use of coarse, fractured rock as an initial layer over permafrost areas could allow air flow and reduce thermal degradation and thaw deformation. And the use of lightweight fill will also be considered as a means of controlling embankment deformation. Where construction and material site development requires removal of the vegetative mat, the mat will be stockpiled for use in re-vegetation of exposed slopes.

SECTION 5

# Cost Estimates

## 5.1 Cost Estimates

The cost estimates were prepared from information available at the time of the estimate, and have been developed as a source of guidance for the evaluation and planning of future project development. The final costs of the proposed project will depend on actual labor and material costs, competitive market conditions, final project costs, implementation schedule, and other variables. Therefore, the final project costs will vary from the estimates presented in this reconnaissance study. Project feasibility and funding needs must be carefully reviewed before future financial decisions are made to help ensure proper project evaluation and adequate funding.

### 5.1.1 Roadway and Docks Cost Estimate

To build a quantity-based cost estimate, a terrain model was created based on existing mapping—no field survey was performed. The horizontal and vertical alignment was then created, and a typical roadway template was pushed full length of the alignment, allowing calculation of excavation and embankment quantities including surface and base course quantities. As the excavation occurs in the "high" areas of the alignment, 75 percent of the calculated excavation volume is assumed to be useable and offsets a portion of the embankment quantity. Quantities for the two docks were simple volume calculations based on a 5-foot-thick embankment over 5 acres for each dock. Culvert quantities were estimated using locations identified in the 1981 Study and assumed a minimum 2-foot cover in addition to a minimum embankment height of 5 feet. For example, a 72-inch-diameter culvert pipe requires an embankment height of 8 feet to provide the necessary cover. In addition, culverts were assumed to lie on a modest 6:1 sidehill slope rather than flat land, which increased culvert lengths. As discussed earlier, care was taken to locate the Primary Corridor alignment to minimize grades and steep side slopes. This is a significant advantage over Corridors A and B both in ease of heavy haul and embankment/excavation cost. The roadway cost estimates assume 2.5 percent for permitting and 10 percent for design and construction management, and include 15 percent for undefined work. The cost estimates do not include utilities (expected to be nominal), right-of-way (ROW), or maintenance costs.

| | |
|---|---|
| Total of Bid Items | $92,860,000 |
| Environmental Permitting | $4,643,000 |
| Design and Construction Engineering | $16,715,000 |
| Contingency | $13,929,000 |
| Total Estimated Cost | $128,147,000 |
| Cost per mile | $3,860,000 |

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SECTION 6

# Conclusions and Recommendations

## 6.1 Conclusions

### 6.1.1 Corridor Selection

The Primary Corridor is superior in many respects to alternative Corridors A and B. It would take advantage of existing infrastructure in the Kalskag area, on the north bank of the Kuskokwim River—including barge access 25 to 40 miles closer to Bethel than Corridors A and B, respectively, and an airport with a 3,200- by 75-foot gravel surfaced runway. The community of Aniak is proximate to the southern terminus of both Corridors A and B and has an airport with a 6,000- by 150-foot paved runway. However, virtually all of Aniak's existing infrastructure, including the airport, is located on the south bank of the Kuskokwim River. Aniak also lies about 30 miles upriver from Kalskag.

The Primary Corridor is also located on the western flanks of the Portage Mountains, allowing design of an alignment with very modest grades of less than 5 percent, which provides the dual benefit of minimizing the cost of earthwork during construction and easing the transportation of goods between the Yukon and Kuskokwim Rivers. Although Corridors A and B have been located to minimize grades (5 to 7 percent), both corridors nevertheless must negotiate through the Portage Mountains, resulting in additional earthwork cost per mile and a more difficult route for heavy haul traffic. The Primary Corridor is 33 miles long, comparable to both Corridors A and B at 27 and 36 miles long, respectively. However, selection of the North Option for the Primary Corridor would add approximately 7 miles, making this the longest route. The northern terminus of the Primary Corridor has been identified in the 1981 Study as the optimum location for a dock, the alternatives being approximately 10 miles farther upstream, incurring additional barge navigation difficulty and travel time. In order to connect the two river systems, the northern third of all three corridors necessarily falls on the ice-rich wetlands of the Yukon River Delta.

### 6.1.2 Land Status and Right-of-Way

Land Status for the Primary Corridor was researched for and described in the 1981 Study, and additional information has been obtained that generally verifies the initial research and includes Corridors A and B. Regardless of the corridor/option selected, an ROW for both the docks and the road will need to be defined and acquired.

Land status for the Primary Corridor, 33 miles long, includes private and Township lands in the vicinity of Kalskag, private Alaska Native Claims Settlement Act (ANSCA) Native-Conveyed or Interim-Conveyed lands for approximately 15 miles, followed by approximately 17 miles within the Yukon Delta National Wildlife refuge, ending on or very near a native allotment at Paimiut Slough depending on final design.

Corridor B, approximately 27 miles long, traverses private ANSCA Native-Conveyed or Interim-Conveyed lands for approximately 5 miles before entering BLM Vacant Unappropriated, Unreserved public land for approximately 19 miles. The final 3 miles of this corridor falls within the Yukon Delta National Wildlife Refuge before reaching Paimiut Slough at the same location and same native allotment as the Primary Corridor.

Corridor C, approximately 36 miles long, traverses private ANSCA Native-Conveyed or Interim-Conveyed lands for approximately 13 miles before entering BLM Vacant Unappropriated, Unreserved public land for approximately 4 miles. The next 12 miles cross State Patented or Tentatively Approved lands before entering private ANSCA Native-Conveyed or Interim-Conveyed lands again for about 7 miles before reaching Paimiut Slough on BLM land.

Land status in Alaska can be complex and continues to evolve. Explicit property ownership will need to be verified or updated at key decision points associated with project development, such as NEPA documentation and Final Design.

### 6.1.3 Geotechnical Considerations

The 1981 Study provides an excellent representation of the area geology short of actually initiating a full field investigation—including drilling, sampling, and testing—which acknowledges the probable existence and locations of continuous permafrost (with possible localized exceptions) and ice-rich silt, as well as possible rock sources and gravel and sand deposits. Additional field reconnaissance would be useful to determine whether a material source can be found near the northern end of the Portage Mountains. Additionally, all of the identified material sources need to be confirmed with respect to both quality and quantity to substantiate that materials can be found along the selected corridor. A lack of readily available construction materials would likely require barging of material from both the Yukon and Kuskokwim Rivers adding substantial cost to the project.

### 6.1.4 Drainage Considerations

The 1981 Study provides an excellent analysis of the area hydrology, particularly along the Primary Corridor. The 100-year flood elevation (56 feet) would inundate the southern section of the alignment to a depth of about 10 feet. The roadway and docks will be designed to the 25-year flood elevation.

Drainage basins from the 1981 Study have been verified and updated to reflect current alignment revisions. The resulting culvert requirements do not differ significantly from those of the 1981 Study.

### 6.1.5 Design Considerations

Design criteria selected in the 1981 Study have been retained, apart from changing embankment side slopes from 2:1 to 4:1 for embankment heights of 5 feet or less. Embankment slopes steepen with depth to control embankment quantities. Consideration must be given to minimize permafrost thaw and subsequent embankment deformation.

### 6.1.6 Environmental Considerations

Four issues will require significant attention during the NEPA process: (1) ROW acquisition, (2) impact on the Yukon Delta National Wildlife Refuge, (3) Threatened and Endangered Species, and (4) cultural history and significance of a "portage" between the Yukon and Kuskokwim Rivers in the project area.

### 6.1.7 Cost Considerations

As previously discussed, the cost of the project will relate primarily to the availability of construction materials—both quality and quantity. If the identified potential material sources cannot be economically mined, material will need to be transported by barge from both the Yukon and Kuskowim Rivers, substantially increasing the cost of the project.

## 6.2 Feasibility

The 1981 Study construction feasibility statement remains valid in its statement that "[c]onstruction of the proposed project, using standard construction practices, is entirely feasible. Except for extra mobilization and demobilization cost not normal to urban projects, construction costs do not exceed unit costs of similar roads and docks."

The project also remains feasible environmentally. However, the time and effort associated with receiving ROW and approval to construct in the Yukon Delta National Wildlife Refuge must not be underestimated. The assertion of RS2477 rights based upon historical use of a portage between the two river systems will provide a strong argument in favor of the project, though state claim of RS2477 rights through federal conservation systems remains difficult. Title 11 of ANILCA—which provides for access across federal conservation units—is another avenue for pursuit of the necessary ROW, but this mechanism will also require significant time and effort with no up-front guarantee of success.

## 6.3 Recommendations

- Initiate additional geotechnical reconnaissance to verify availability of the quality and quantity of construction materials along the corridor required for construction of the road and docks.
- Initiate discussions with the manager of the Yukon Delta National Wildlife Refuge as to the process and time requirements for acquisition of a ROW within the refuge for the north end of the project.
- Advise the local communities along both the Yukon and Kuskokwim Rivers as to the status and progress of the project.
- Initiate the NEPA process.

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SECTION 7

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# Appendix A

# Primary Corridor Plan and Profile

# Appendix B
# Environmental and Regulatory Considerations

# Appendix C

# Cost Estimate